

**Appendix B**  
**Risk Assessment Discussion and Calculations**

## **PARCEL A RISK ASSESSMENT DISCUSSION AND CALCULATIONS**

Additional risk assessment calculations were performed to supplement the initial post-demolition risk assessment previously submitted to the RWQCB and HERD (Integrated 1998b). These additional risk calculations were used to evaluate additional potential human health risk associated with deep soil residual impacts in Parcel A. Human health risks were evaluated for the following additional potential exposure pathways using deep soil and groundwater investigation results:

- inhalation of VOCs in indoor air from upward VOC vapor migration from groundwater into onsite buildings
- inhalation of VOCs in indoor air due to VOC migration from deep soil leachate migration to groundwater and subsequent VOC vapor migration from groundwater into indoor air

The potential for further degradation of groundwater due to chemical leaching from soil to groundwater was also evaluated.

It should be noted that this evaluation includes all areas of Parcel A with the exception of the Harbrogate Way Easement (Figure 2). This easement is the portion of Parcel A deep soil that is impacted with VOCs from sources located in Parcel C. This easement is being addressed as part of the Parcel C environmental program.

The results of the additional risk assessment and the groundwater quality impact assessment are presented below.

### **GROUNDWATER QUALITY IMPACT ASSESSMENT**

The objective of the groundwater quality impact assessment is to evaluate whether existing chemical concentrations in onsite deep soils have the potential to degrade existing groundwater quality. Even though shallow groundwater beneath and in proximity to subject parcel is not used as a domestic water supply, the RWQCB requested, as a conservative measure, that an evaluation be conducted of potential downward chemical migration from soil resulting in possible degradation of the Bellflower aquitard. The Bellflower aquitard is the most shallow water-bearing zone beneath Parcel A. This evaluation conservatively and unrealistically assumes that the Bellflower aquitard is a part of the underlying aquifers providing domestic water supply. As described below, the assessment was conducted by further assuming a conservative scenario regarding chemical migration and mixing in groundwater following approved EPA and RWQCB methodology and assumptions.

The maximum COPC concentrations in soil were compared to site-specific soil screening levels (SSLs) derived from California drinking water standards, specifically primary or secondary MCLs, for depths of 25, 40 and 50 feet below ground surface. Initial site-specific

SSLs were derived using the following formula presented in Section 2.5 of the EPA document entitled *Soil Screening Guidance: Technical Background Document (TBD)*, dated July 1996:

$$\text{Initial SSL} = \text{MCL} [(\text{K}_{\text{oc}} * \text{f}_{\text{oc}}) + ((\text{O}_w + \text{O}_a * \text{H}')/\text{P}_b)] \quad (\text{Equation 1})$$

Where:

Initial SSL = soil screening level, mg/kg;  
MCL = maximum contaminant level, mg/L;  
 $\text{K}_{\text{oc}}$  = soil organic carbon-water partition coefficient, L/kg;  
 $\text{f}_{\text{oc}}$  = organic carbon content of soil, kg/kg;  
 $\text{O}_w$  = water-filled soil porosity,  $\text{L}_{\text{water}}/\text{L}_{\text{soil}}$ ;  
 $\text{O}_a$  = air-filled soil porosity,  $\text{L}_{\text{air}}/\text{L}_{\text{soil}}$ ;  
 $\text{H}'$  = Henry's law constant, dimensionless; and  
 $\text{P}_b$  = dry soil bulk density, kg/L.

Site-specific geotechnical parameters are presented in Table B-1. The above equation is a partitioning formula, which does not account for chemical attenuation during migration in soil or mixing with groundwater. To better represent contaminant migration in the soil column, attenuation factors were applied to the initial SSLs. The attenuation factors for VOCs were derived using Table 5-14: Average Attenuation Factor for Different Distance above Ground Water and Lithology presented in the RWQCB's May 1996 *Interim Site Assessment & Cleanup Guidebook* (the Guidebook), and the attenuation factors for non-VOCs were derived using the formulas presented in Appendix A of that same document. The attenuation factors were derived assuming site-specific average soil particle size distributions and distances of 40, 25, and 15 feet from soil impacts to the groundwater table. Groundwater at the site is approximately 65 feet bgs.

An EPA default dilution attenuation factor (DAF) of 20 was applied to the initial SSLs to account for limited groundwater mixing. This EPA default value is presented in the above-referenced July 1996 EPA document, and was used by EPA to develop generic SSLs. The resulting site-specific SSL for each detected chemical at a particular depth to groundwater is equal to the initial SSL (assuming no soil attenuation or groundwater mixing) multiplied by the product of the associated soil attenuation factor and a groundwater mixing factor of 20.

The site-specific SSLs are conservative. Both the soil attenuation factor and the DAF are likely greater than estimated. A greater soil attenuation factor and greater DAF would result in higher SSL concentrations, which would allow for higher soil concentrations to be left in place and still be protective of groundwater. For instance:

- In the soil attenuation factor derivation, the RWQCB assumes that the chemical transport rate is 10 times higher (chemicals migrate 10 times faster) in the groundwater smear zone, assumed to be present 40 feet above groundwater table. Actual groundwater elevations at the Facility between 1988 to 2001 indicate the groundwater table has risen 10 feet and fallen 2 feet over this period. Based on the historical data for the Facility, it appears that

the assumed 40-foot zone of increased chemical transport is over four times larger than the actual data suggests. The actual soil attenuation factor is, thus, likely greater than estimated.

The EPA default DAF of 20 assumes no attenuation once the chemicals reach the groundwater table, no chemical degradation, a receptor well located at the edge of the chemical source, and a chemical source of 0.5 acre. In reality, chemicals do attenuate to some degree as they migrate in the saturated zone, most organic chemicals naturally degrade in the environment, no receptor wells are located within miles of the Facility, and contaminant sources on Parcel B are less than 0.5 acre. The actual DAF is, thus, likely greater than estimated.

The calculation of site-specific SSLs for COPCs that have promulgated MCLs is presented in Tables B-3 and B-8. A comparison of the calculated site-specific SSLs with the maximum COPC concentrations in soil is also presented in Table B-3, B-5, and B-7.

The maximum chemical concentrations in onsite soil do not exceed the site-specific groundwater protection concentrations (i.e., site-specific SSLs), with the exception 1,1-DCE and TCE. The concentrations of 1,1-DCE and TCE in deep soil that exceed SSLs are identified in Figure 6. These include:

- 1,1-DCE and/or TCE concentrations at depths greater than 30 feet bgs in boring 1-6/2BB-1-6
- a concentration of 1,1-DCE at a depth of 50 feet bgs in boring 1-23, and
- a concentration of TCE at depths of 25 and 30 feet bgs in boring B15 and B-15-FS, and depths of 40 and 50 feet bgs in boring NE-1/2BB-NE-2.

The above noted concentrations of 1,1-DCE and TCE in deep soil are less than two times greater than the SSLs, with the exception of 1,1-DCE concentrations in boring 1-6/2BB-1-6. The highest 1,1-DCE concentration in this boring is almost four times greater than the SSL. It is expected that the elevated concentrations of 1,1-DCE and TCE in boring 1-6/2BB-1-6, and of TCE in boring NE-2/2BB-NE-2 will be remediated by the soil vapor extraction (SVE) treatment system scheduled to be started in April 2001. Concentrations of TCE in boring B15 and B-15-FS appear to be related to apparent releases from a former hazardous waste accumulation area nearby. These residual concentrations appear to be localized, and since the SSLs are very conservative values and the deep soil concentrations are less than two times the SSL, they do not appear to pose a significant threat to groundwater quality beneath Parcel A.

#### **INHALATION OF INDOOR AIR – VOC VAPOR MIGRATION FROM GROUNDWATER INTO INDOOR AIR**

Human health risk associated with VOC vapor migration from groundwater into onsite buildings and subsequent inhalation of indoor air was calculated for the onsite commercial/industrial worker. These risks were estimated using the County of San Diego

Department of Environmental Health (DEH) vapor migration model and the highest VOC concentrations in groundwater obtained from the most recent samples collected from groundwater monitoring wells WCC-04S, WCC-05S, WCC-07S, WCC-11S, and WCC-12S. The model results are presented in Appendix C, and a summary of the results is presented in Table B-9.

As shown in Table B-9, both the estimated excess cancer risk and estimated hazard index are less than the OEHHA-approved acceptable risk thresholds of  $1.0 \times 10^{-5}$  and 1.0, respectively. Thus, the existing VOC concentrations in groundwater beneath Parcel A do not pose an indoor air health risk greater than OEHHA-approved risk levels.

#### **INHALATION OF INDOOR AIR – VOC MIGRATION FROM SOIL LEACHATE MIGRATION TO GROUNDWATER AND SUBSEQUENT VOC VAPOR MIGRATION FROM GROUNDWATER INTO INDOOR AIR**

VOCs in soil may leach into groundwater and subsequently volatilize from groundwater and, through upward diffusion, migrate through the soil column into indoor air. The SSL equation (Equation 1) was used to estimate maximum VOC concentrations in pore water by substituting the SSL parameter with maximum onsite soil concentrations in the equation to derive the maximum pore water concentration instead of the MCL:

$$C_{pw} = C_s / [(K_{oc} * f_{oc}) + ((O_w + O_a * H')/P_b)] \quad (\text{Equation 2})$$

Where:

$C_{pw}$  = maximum VOC concentration in pore water, mg/L; and  
 $C_s$  = maximum VOC concentration in soil, mg/kg.

The estimated maximum VOC concentration in groundwater was then derived by applying no soil attenuation factor (attenuation factor of 1) and the EPA DAF of 20 to the maximum pore water concentration. The soil attenuation factor of 1 is extremely conservative in that its use provides the assumption that the pore water concentrations are present at the groundwater table. Thus, it is assumed that no soil attenuation occurs, even though the maximum concentrations of VOCs on Parcel A were measured at various depths in the soil column where some level of attenuation would be expected. The resulting estimated maximum VOC concentrations in groundwater are presented in Table B-10.

Human health risk associated with the inhalation of vapors in buildings resulting from migration of VOC vapors from the above-noted estimated chemical concentrations in groundwater were estimated for the onsite commercial/industrial worker using the DEH vapor migration model. The model results are presented in Appendix C, and a summary of the results is presented in Table B-11. As shown in Table B-11, both the estimated excess cancer risk and estimated hazard index are less than the risk thresholds of  $1.0 \times 10^{-5}$  and 1.0,

respectively. Thus, vapor migration from groundwater due to VOC leaching to groundwater does not pose an indoor air health risk greater than acceptable risk levels.

### CUMULATIVE HUMAN HEALTH RISKS

As indicated in the previous sections, the following additional potential exposure pathways were evaluated using the deep soil investigation results:

- inhalation of VOCs in indoor air from upward VOC vapor migration from groundwater into onsite buildings
- inhalation of VOCs in indoor air due to VOC migration from deep soil leachate migration to groundwater and subsequent VOC vapor migration from groundwater into indoor air

The risks associated with the above-listed exposure pathways, and the estimated risks to potential onsite receptors as presented in the post-demolition risk assessment are summarized in Table B-12. As shown in Table B-12, adding the estimated risks from the above-listed pathways to the estimated risks to the potential on-site receptors do not result in risks greater than the OEHHA-approved acceptable risk levels.

**Table B-2. Soil Particle Size Distribution at BRC Former C-6 Facility**

Sample ID	Date Sampled	Depth (feet bgs)	Sieve Analysis (Soil Type)	Median Grain Size (mm)	Particle Size Distribution, wt. Percent						
					Gravel	Coarse	Medium	Fine	TOTAL	Silt	Clay
EIA290176-004 (I-34-20)	1/29/2001	20	Silt	0.032	0.00	0.00	0.00	31.19	31.19	54.83	13.99
EIA290176-012 (D-29-20)	1/29/2001	20	Silt	0.036	0.00	0.00	0.90	27.59	28.49	59.67	11.85
EIA290176-021 (I-25-20)	1/29/2001	20	Silt	0.020	0.00	0.00	0.00	11.21	11.21	69.07	19.72
EIA290176-007 (I-34-50)	1/29/2001	50	Fine sand	0.151	0.00	0.00	0.57	79.33	79.33	17.39	2.71
EIA290176-015 (D-29-50)	1/29/2001	50	Fine sand	0.083	0.00	0.00	3.26	47.93	51.19	39.79	9.01
EIA290176-024 (I-25-50)	1/29/2001	50	Silt	0.027	0.00	0.00	0.04	21.27	21.31	64.99	13.70
						37.22	50.96	11.83			
						50.80	40.72	8.47			

Average (25 feet bgs to groundwater table)

Average (50 feet bgs to groundwater table)

**Table B-3. Derivation of Soil Attenuation Factor for VOCs and Comparison of Maximum Soil Concentrations to Site-specific SSLs Calculated at 25 Feet Below Ground Surface**

CAS No.	Chemical	MCL (mg/L)	$K_{oc}$	$f_{oc}$ <sup>(1)</sup>	$K_d$ <sup>(4,5)</sup>	$H'$ <sup>(1)</sup>	$O_w$	$O_a$ <sup>(3)</sup>	$P_b$ <sup>(3)</sup>	Max. Residual Soil Concentration (mg/kg)	AF at D=15'	Site-specific SSL (mg/kg) at AF at D=15'	Site-specific SSL (mg/kg) at AF at D=20'	Max. > SSL for AF at D=15' and DAF=20
12672-29-6	Aroclor-1248	5.00E-04	3.1E+05	4.05E-04	--	3.5E-02	2.4E-01	2.3E-01	1.42E+00	1.30E-01	19	6.29E-02	1.19E+00	2.39E+01
7440-38-2	Arsenic	5.00E-02	--	4.05E-04	2.90E+01	--	2.4E-01	2.3E-01	1.42E+00	4.50E+00	4	1.46E+00	6.43E+00	1.29E+02
7440-41-7	Beryllium	4.00E-03	--	4.05E-04	7.9E+02	--	2.4E-01	2.3E-01	1.42E+00	9.20E-01	119	3.16E+00	3.78E+02	7.55E+03
117-81-7	Bis(2-ethylhexyl)phthalate	4.00E-03	1.5E+07	4.05E-04	--	4.2E-06	2.4E-01	2.3E-01	1.42E+00	2.00E-01	925	2.45E+01	2.26E+04	4.52E+05
16065-83-1	Chromium (trivalent)	5.00E-02	--	4.05E-04	1.8E+06	--	2.4E-01	2.3E-01	1.42E+00	4.40E+01	272110	9.00E+04	2.45E+10	4.90E+11
7440-50-8	Copper	1.0E+00	--	4.05E-04	4.3E+02	--	2.4E-01	2.3E-01	1.42E+00	5.45E+01	65	4.28E+02	2.77E+04	5.54E+05
75-34-3	1,1-Dichloroethane (1,1-DCA)	5.00E-03	5.3E+01	4.05E-04	--	2.3E-01	2.4E-01	2.3E-01	1.42E+00	6.00E-02	7	1.15E+03	7.78E+03	1.56E+01
107-06-2	1,2-Dichloroethane (1,2-DCA)	5.00E-04	3.8E+01	4.05E-04	--	4.0E-02	2.4E-01	2.3E-01	1.42E+00	8.70E-03	7	9.66E-05	6.55E-04	1.31E+02
75-35-4	1,1-Dichloroethene (1,1-DCE)	6.00E-03	6.5E+01	4.05E-04	--	1.1E+00	2.4E-01	2.3E-01	1.42E+00	1.10E-01	7	2.24E-03	1.52E-02	3.04E+01
75-35-4	cis-1,2-DCE	6.00E-03	3.6E+01	4.05E-04	--	1.7E-01	2.4E-01	2.3E-01	1.42E+00	4.30E-02	7	1.28E-03	8.67E-03	1.73E+01
127-18-4	Tetrachloroethene (PCE)	5.00E-03	2.7E+02	4.05E-04	--	7.5E-01	2.4E-01	2.3E-01	1.42E+00	2.02E-01	7	2.00E-03	1.36E-02	2.72E+01
71-55-6	1,1,1-TCA	2.00E-01	1.4E+02	4.05E-04	--	7.1E-01	2.4E-01	2.3E-01	1.42E+00	1.35E-02	7	6.83E-02	4.63E-01	9.28E+00
79-00-5	1,1,2-TCA	5.00E-03	7.5E+01	4.05E-04	--	3.7E-02	2.4E-01	2.3E-01	1.42E+00	1.80E-02	7	1.04E-03	7.04E-03	1.41E+01
79-01-6	Trichloroethene (TCE)	5.00E-03	9.4E+01	4.05E-04	--	4.2E-01	2.4E-01	2.3E-01	1.42E+00	2.00E-01	7	1.38E-03	9.37E-03	1.87E+01

An SSL was not derived for chemicals that do not have promulgated primary MCLs. These chemicals were not included in the assessment of potential degradation to groundwater quality.

AF = Average attenuation factor based on site lithology (distance to groundwater = 40 feet, 37% sand, 51% silt, and 12% clay).

na = not available

$K_{oc}$  = soil organic carbon-water partition coefficient (L/kg)

$f_{oc}$  = site-specific organic carbon content of soil (kg/kg)

$K_d$  = soil-water partition coefficient (L/kg),  $K_{oc} \times f_{oc}$

$H'$  = dimensionless Henry's law constant

$O_w$  = site-specific average water-filled porosity (by volume)

$O_a$  = site-specific average air-filled porosity (by volume)

$P_b$  = dry soil bulk density (kg/L)

<sup>(1)</sup> Obtained from EPA Region 9 preliminary remediation goal (PRG) physical-chemical data for volatile organic compounds, November 2000

<sup>(2)</sup> Obtained from Risk Assessment Information System (RAIS) Toxicity & Chemical-Specific Factors Data Base, January 2001, [http://risks.lsd.ornl.gov/cgi-bin/tox/TOX\\_select?select=csf](http://risks.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf)

<sup>(3)</sup> Site-specific average values

<sup>(4)</sup> Obtained from EPA Soil Screening Guidance: Technical Background Document (TBD), EPA/540/R-95/123, July 1996, <http://www.epa.gov/cerrpage/superfund/resources/soil/toc.htm>

**Table B-4. Derivation of Soil Attenuation Factors for Non-OCs at 25 Feet Below Ground Surface**

CAS No.	Chemical	$K_{oc}$ <sup>(1,2,4)</sup>	$f_{oc}$ <sup>(3)</sup>	$K_d$ <sup>(2,4)</sup>	$H'$ <sup>(1)</sup>	$O_w$ <sup>(3)</sup>	$O_a$ <sup>(3)</sup>	$P_b$ <sup>(3)</sup>	$O_t$	$AF_{max}$	Distance to Groundwater (feet)	$AF_b$	$AF_T$	
12672-29-6	Aroclor-1248	3.1E+05	4.1E-04	--	3.5E-02	2.43E-01	2.27E-01	1.42E+00	4.70E-01	734	40	73.38	19.01	
7440-38-2	Arsenic	--	--	2.90E-01	2.43E-01	2.27E-01	1.42E+00	4.70E-01	170	40	17.03	4.41	4	
7440-41-7	Beryllium	--	--	7.9E+02	2.43E-01	2.27E-01	1.42E+00	4.70E-01	4612	40	461.20	119.45	119	
117-81-7	Bis (2-ethylhexyl)phthalate	1.5E+07	4.1E-04	--	4.2E-06	2.43E-01	2.27E-01	1.42E+00	4.70E-01	35696	40	3569.57	924.52	925
16065-83-1	Chromium (trivalent)	--	--	1.8E+06	2.43E-01	2.27E-01	1.42E+00	4.70E-01	10506174	40	1050617.38	272109.90	272110	
7440-50-8	Copper	--	--	4.3E+02	2.43E-01	2.27E-01	1.42E+00	4.70E-01	2499	40	249.91	64.73	65	

na = not available

An  $AF_T$  was not derived for chemicals that do not have promulgated primary MCLs. These chemicals were not included in the assessment of potential further degradation to groundwater quality.

$AF_T$  were calculated assuming that the depth between chemical impacts and groundwater is 40 feet and that the soil within this portion of the soil column is comprised of 37% sand, 51% silt, and 12% clay.

$K_{oc}$  = soil organic carbon-water partition coefficient (L/kg)

$f_{oc}$  = site-specific organic carbon content of soil (kg/kg)

$K_d$  = soil-water partition coefficient (L/kg),  $K_{oc} \times f_{oc}$

$H'$  = dimensionless Henry's law constant

$O_w$  = site-specific average water-filled porosity (by volume)

$O_a$  = site-specific average air-filled porosity (by volume)

$O_t$  = site-specific average total porosity (by volume)

$P_b$  = dry soil bulk density (kg/L)

<sup>(1)</sup> Obtained from EPA Region 9 preliminary remediation goal (PRG) physical-chemical data for volatile organic compounds, November 2000

<sup>(2)</sup> Obtained from Risk Assessment Information System (RAIS) Toxicity & Chemical-Specific Factors Data Base, January 2001, [http://iris.lsd.ornl.gov/cgi-bin/tox/TOX\\_X\\_select?select=csf](http://iris.lsd.ornl.gov/cgi-bin/tox/TOX_X_select?select=csf)

<sup>(3)</sup> Site-specific average values

<sup>(4)</sup> Obtained from EPA Soil Screening Guidance: Technical Background Document (TBD), EPA/540/R-95/128, July 1996, <http://www.epa.gov/oerrpage/superfund/resources/soil/loc.htm>

**Table B-5. Derivation of Soil Attenuation Factor for VOCs and Comparison of Maximum Soil Concentrations to Site-specific SSLs Calculated at 40 Feet Below Ground Surface**

CAS No.	Chemical	MCL (mg/L)	$K_{oc}$ (1,2)	$f_{oc}$ (3)	$K_d$ (4,5)	$H^*$ (1)	$O_w$ (3)	$O_a$ (3)	$P_b$ (3)	Max. Residual Soil Concentration (mg/kg)	AF at D=15'	Site-specific SSL (mg/kg) at AF = 1	Site-specific SSL (mg/kg) at AF at D=15'	Site-specific SSL (mg/kg) at AF at D=15' and DAF=20?
7440-38-2	Arsenic	5.00E-02	--	4.05E-04	2.90E+01	--	2.4E-01	2.3E-01	1.42E+00	2.30E+01	3	1.46E+00	4.16E+00	8.32E+01
7440-41-7	Beryllium	4.00E-03	--	4.05E-04	7.9E+02	--	2.4E-01	2.3E-01	1.42E+00	4.10E-01	75	3.16E+00	2.36E+02	4.73E+03
16065-83-1	Chromium (trivalent)	5.00E-02	--	4.05E-04	1.8E+06	--	2.4E-01	2.3E-01	1.42E+00	5.10E+01	170069	9.00E+04	1.53E+10	3.06E+11
7440-50-8	Copper	1.0E+00	--	4.05E-04	4.3E+02	--	2.4E-01	2.3E-01	1.42E+00	3.30E+01	41	4.28E+02	1.74E+04	3.47E+05
75-35-4	1,1-Dichloroethene (1,1-DCE)	6.00E-03	6.5E+01	4.05E-04	--	1.1E+00	2.4E-01	2.3E-01	1.42E+00	9.00E-01	4	2.24E+03	9.61E-03	Yes
71-55-6	1,1,1-TCA	2.00E-01	1.4E+02	4.05E-04	--	7.1E-01	2.4E-01	2.3E-01	1.42E+00	1.50E-02	4	6.83E-02	2.93E-01	No
79-01-6	Trichloroethene (TCE)	5.00E-03	9.4E+01	4.05E-04	--	4.2E-01	2.4E-01	2.3E-01	1.42E+00	1.50E-01	4	1.38E-03	5.93E-03	Yes

An SSL was not derived for chemicals that do not have promulgated primary MCLs. These chemicals were not included in the assessment of potential degradation to groundwater quality.

AF = Average attenuation factor based on site lithology (distance to groundwater = 25 feet, 37% sand, 51% silt, and 12% clay).

na = not available

$K_{oc}$  = soil organic carbon-water partition coefficient (L/kg)

$f_{oc}$  = site-specific organic carbon content of soil (kg/kg)

$K_d$  = soil-water partition coefficient (L/kg),  $K_{oc} \times f_{oc}$

$H^*$  = dimensionless Henry's law constant

$O_w$  = site-specific average water-filled porosity (by volume)

$O_a$  = site-specific average air-filled porosity (by volume)

$P_b$  = dry soil bulk density (kg/L)

(1) Obtained from EPA Region 9 preliminary remediation goal (PRG) physical-chemical data for volatile organic compounds, November 2000

(2) Obtained from Risk Assessment Information System (RAIS) Toxicity & Chemical-Specific Factors Data Base, January 2001, [http://risk.lsd.ornl.gov/cgi-bin/tox/TOX\\_select?select=csf](http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf)

(3) Site-specific average values

(4) Obtained from EPA Soil Screening Guidance: Technical Background Document (TBD), EPA-540/R-95/128, July 1996, <http://www.epa.gov/oerrpage/superfund/resources/soil/toc.htm>

**Table B-6. Derivation of Soil Attenuation Factors for Non-VOCs at 40 Feet Below Ground Surface**

CAS No.	Chemical	$K_{oc}$ <sup>(1,2,4)</sup>	$f_{oc}$ <sup>(3)</sup>	$K_d$ <sup>(2,4)</sup>	$H'$ <sup>(1)</sup>	$O_w$ <sup>(3)</sup>	$O_a$ <sup>(3)</sup>	$P_b$ <sup>(3)</sup>	$O_t$	$AF_{max}$	Distance to Groundwater (feet)	$AF_b$	$AF_T$	$AF_T$
7440-38-2	Arsenic	--	--	2.90E+01	2.43E-01	2.27E-01	1.42E+00	4.70E-01	170	25	11.02	2.85	3	
7440-41-7	Beryllium	--	--	7.9E+02	2.43E-01	2.27E-01	1.42E+00	4.70E-01	4612	25	288.63	74.75	75	
16055-83-1	Chromium (trivalent)	--	--	1.8E+06	2.43E-01	2.27E-01	1.42E+00	4.70E-01	10506174	25	636636.24	170068.79	170069	
7440-50-8	Copper	--	--	4.3E+02	2.43E-01	2.27E-01	1.42E+00	4.70E-01	2499	25	156.57	40.55	41	

na = not available

An  $AF_T$  was not derived for chemicals that do not have promulgated primary MCLs. These chemicals were not included in the assessment of potential further degradation to groundwater quality.

$AFT$  were calculated assuming that the depth between chemical impacts and groundwater is 25 feet and that the soil within this portion of the soil column is comprised of 37% sand, 5% silt, and 12% clay.

$K_{oc}$  = soil organic carbon-water partition coefficient ( $L/kg$ )

$f_{oc}$  = site-specific organic carbon content of soil ( $kg/kg$ )

$K_d$  = soil-water partition coefficient ( $L/kg$ ),  $K_{oc} \times f_{oc}$

$H'$  = dimensionless Henry's law constant

$O_w$  = site-specific average water-filled porosity (by volume)

$O_a$  = site-specific average air-filled porosity (by volume)

$O_t$  = site-specific average total porosity (by volume)

$P_b$  = dry soil bulk density ( $kg/L$ )

<sup>(1)</sup> Obtained from EPA Region 9 preliminary remediation goal (PRG) physical-chemical data for volatile organic compounds, November 2000

<sup>(2)</sup> Obtained from Risk Assessment Information System (RAIS) Toxicity & Chemical-Specific Factors Data Base, January 2001, [http://risk.lsd.ornl.gov/cgi-bin/tox/TOX\\_select?select=csf](http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf)

<sup>(3)</sup> Site-specific average values

<sup>(4)</sup> Obtained from EPA Soil Screening Guidance: Technical Background Document / TBD, EPA/540/R-95/128, July 1996, <http://www.epa.gov/oerrpage/supfund/resources/soil/toc.htm>

**Table B-7. Derivation of Soil Attenuation Factor for VOCs and Comparison of Maximum Soil Concentrations to Site-specific SSLs Calculated at 50 Feet Below Ground Surface**

CAS No.	Chemical	MCL (mg/L)	$K_{oc}$ <sup>(1,2)</sup>	$f_{oc}$ <sup>(3)</sup>	$K_d$ <sup>(4,5)</sup>	$H'$ <sup>(1)</sup>	$O_w$ <sup>(3)</sup>	$O_a$ <sup>(3)</sup>	$P_b$ <sup>(3)</sup>	Max. Residual Soil Concentration (mg/kg)	Site-specific SSL (mg/kg) at AF at D=15'		Max > SSL for AF at D=15' and DAF=20	
											Site-specific SSL (mg/kg) at AF at D=15'	Site-specific SSL (mg/kg) at AF at D=15' and DAF=20		
7440-38-2	Arsenic	5.00E-02	--	4.05E-04	2.90E+01	--	2.4E-01	2.3E-01	1.42E+00	2.30E+01	2	1.46E+00	2.32E+00	4.63E+01
7440-41-7	Beryllium	4.00E-03	--	4.05E-04	7.9E-02	--	2.4E-01	2.3E-01	1.42E+00	4.10E-01	40	3.16E+00	1.25E+02	2.50E+03
117-81-7	Bis(2-ethylhexyl)phthalate	4.00E-03	1.5E+07	4.05E-04	--	4.2E-06	2.4E-01	2.3E-01	1.42E+00	1.30E-01	317	2.45E+01	7.75E+03	1.55E+05
16065-83-1	Chromium (trivalent)	5.00E-02	--	4.05E-04	1.8E-06	--	2.4E-01	2.3E-01	1.42E+00	5.10E+01	89860	9.00E+04	8.09E+09	1.62E+11
7440-50-8	Copper	1.0E+00	--	4.05E-04	4.3E-02	--	2.4E-01	2.3E-01	1.42E+00	3.30E+01	22	4.28E+02	9.21E+03	1.84E+05
75-35-4	1,1-Dichloroethene (1,1-DCE)	6.00E-03	6.5E+01	4.05E-04	--	1.1E+00	2.4E-01	2.3E-01	1.42E+00	1.60E-01	2	2.24E+03	4.77E-03	No
71-55-6	1,1,1-TCA	2.00E-01	1.4E+02	4.05E-04	--	7.1E-01	2.4E-01	2.3E-01	1.42E+00	1.50E-02	2	6.83E-02	1.45E-01	2.91E+00
79-01-6	Trichloroethene (TCE)	5.00E-03	9.4E+01	4.05E-04	--	4.2E-01	2.4E-01	2.3E-01	1.42E+00	1.10E-01	2	1.38E-03	2.94E-03	5.89E-02

An SSL was not derived for chemicals that do not have promulgated primary MCLs. These chemicals were not included in the assessment of potential degradation to groundwater quality.

AF = Average attenuation factor based on site lithology (distance to groundwater = 15 feet, 51% sand, 41% silt, and 8% clay).

na = not available

$K_{oc}$  = soil organic carbon-water partition coefficient (L/kg)

$f_{oc}$  = site-specific organic carbon content of soil (kg/kg)

$K_d$  = soil-water partition coefficient (L/kg),  $K_{oc} \times f_{oc}$

$H'$  = dimensionless Henry's law constant

$O_w$  = site-specific average water-filled porosity (by volume)

$O_a$  = site-specific average air-filled porosity (by volume)

$P_b$  = dry soil bulk density (kg/L)

<sup>(1)</sup> Obtained from EPA Region 9 preliminary remediation goal (PRG) physical-chemical data for volatile organic compounds, November 2000

<sup>(2)</sup> Obtained from Risk Assessment Information System (RAIS) Toxicity & Chemical-Specific Factors Data Base, January 2001, [http://risk.lsd.ornl.gov/cgi-bin/tox/TOX\\_select?select=csf](http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf)

<sup>(3)</sup> Site-specific average values

<sup>(4)</sup> Obtained from EPA Soil Screening Guidance: Technical Background Document (TBD), EPA/540/R-95/128, July 1996, <http://www.epa.gov/oerrpage/superfund/resources/soil/toc.htm>

**Table B-8. Derivation of Soil Attenuation Factors for Non-VOCS at 50 Feet Below Ground Surface**

CAS No.	Chemical	$K_{oc}$ (1,2,4)	$f_{oc}$ (3)	$K_d$ (2,4)	$H^*$ (1)	$O_w$ (3)	$O_a$ (3)	$P_b$ (3)	$O_t$	$AF_{max}$	Distance to Groundwater (feet)	$AF_b$	$AF_T$	$AF_T$
7440-38-2	Arsenic	--	--	2.90E+01	2.16E-01	2.85E-01	1.35E+00	5.01E-01	182	15	7.46	1.59	2	
7440-41-7	Beryllium	--	--	7.9E+02	2.16E-01	2.85E-01	1.35E+00	5.01E-01	4939	15	185.82	39.58	40	
117-81-7	Bis (2-ethylhexyl)phthalate	1.5E+07	4.20E-04	--	4.2E-06	2.16E-01	2.85E-01	1.35E+00	5.01E-01	39639	15	1487.07	316.75	317
16065-33-1	Chromium (trivalent)	--	--	1.8E+06	2.16E-01	2.85E-01	1.35E+00	5.01E-01	11250001	15	421875.66	89859.52	89860	
7440-50-8	Copper	--	--	4.3E+02	2.16E-01	2.85E-01	1.35E+00	5.01E-01	2676	15	100.98	21.51	22	

na = not available

An  $AF_T$  was not derived for chemicals that do not have promulgated primary MCLs. These chemicals were not included in the assessment of potential further degradation to groundwater quality.

$AF_T$  were calculated assuming that the depth between chemical impacts and groundwater is 15 feet and that the soil within this portion of the soil column is comprised of 51% sand, 41% silt, and 8% clay.

$K_{oc}$  = soil organic carbon-water partition coefficient ( $L/kg$ )

$f_{oc}$  = site-specific organic carbon content of soil ( $kg/kg$ )

$K_d$  = soil-water partition coefficient ( $L/kg$ ),  $K_{oc} \times f_{oc}$

$H$  = dimensionless Henry's law constant

$O_w$  = site-specific average water-filled porosity (by volume)

$O_a$  = site-specific average air-filled porosity (by volume)

$O_t$  = site-specific average total porosity (by volume)

$P_b$  = dry soil bulk density ( $kg/L$ )

(1) Obtained from EPA Region 9 preliminary remediation goal (PRG) physical-chemical data for volatile organic compounds, November 2000

(2) Obtained from Risk Assessment Information System (RAIS) Toxicity & Chemical-Specific Factors Data Base, January 2001, [http://risk.sci.ornl.gov/cgi-bin/tox/TOX\\_select?select?csf](http://risk.sci.ornl.gov/cgi-bin/tox/TOX_select?select?csf)

(3) Site-specific average values

(4) Obtained from EPA Soil Screening Guidance: Technical Background Document (TBD), EPA/540/R-95/128, July 1996, <http://www.epa.gov/oerrpage/superfund/resources/soil/tbd.htm>

**Table B-9**  
**Summary of Risk Associated with VOC Vapor Migration from Groundwater**

Chemical	Closest Groundwater Monitoring Well	Date Sampled	Groundwater Monitoring Well Concentration (mg/L)	Excess Cancer Risk	Estimated Hazard Index
Carbon disulfide	WCC-7S	Jan. 24, 2001	0.002	No Slope Factor	0.00000028
Chloroform	WCC-12S	Jan. 22, 2001	0.002	$4.8 \times 10^{-11}$	0.000000082
1,1-DCA	WCC-12S	Jan. 22, 2001	0.018	$1.5 \times 10^{-10}$	0.00000051
1,1-DCE	WCC-4S	Jan. 24, 2001	2	$2.9 \times 10^{-6}$	0.0023
cis-1,2-DCE	WCC-11S	Jan. 23, 2001	0.009	No Slope Factor	0.0000027
trans-1,2-DCE	WCC-4S	Jan. 24, 2001	0.015	No Slope Factor	0.0000048
Toluene	WCC-7S	Jan. 24, 2001	0.009	No Slope Factor	0.00000058
1,1,2-TCA	WCC-7S	Jan. 24, 2001	0.0013	$1.8 \times 10^{-11}$	0.00000022
TCE	WCC-4S	Jan. 24, 2001	1.1	$3.1 \times 10^{-8}$	0.000050
Trichloro- fluoromethane	WCC-5S	Jan. 23, 2001	0.00052	No Slope Factor	0.00000021
1,2,4-Trimethyl- benzene	WCC-5S	Jan. 23, 2001	0.00021	No Slope Factor	0.00000050
1,3,5 Trimethyl- benzene	WCC-12S	Jan. 22, 2001	0.00051	No Slope Factor	0.0000017
Total				$2.9 \times 10^{-6}$	0.0024

**Table B-10. Derivation of Estimated Maximum VOC Concentrations in Groundwater at Parcel A Using a Site-specific SSL Equation**

CAS No.	Chemical	Max. Residual Soil Concentration (mg/kg)	$K_{oc}^{(1)}$	$f_{oc}^{(2)}$	$K_d^{(3)}$	$H^{\prime}$	$O_w^{(1)}$	$O_a^{(2)}$	$P_b^{(2)}$	Pore Water Conc. (mg/L)	Groundwater Conc. (mg/L) = Pore Water Conc. / AF / DAF
75-34-3	1,1-DCA	6.00E-02	5.3E+01	4.05E-04	--	2.3E-01	2.4E-01	1.42E+00	2.3E-01	1.42E+00	2.6E-01
107-06-2	1,2-DCA	8.70E-03	3.8E+01	4.05E-04	--	4.0E-02	2.4E-01	1.42E+00	4.5E-02	1.42E+00	4.5E-02
75-35-4	1,1-DCE	9.00E-01	6.5E+01	4.05E-04	--	1.1E+00	2.4E-01	1.42E+00	2.4E+00	1.42E+00	1.2E-01
540-59-0	1,2-DCE	6.10E-03	3.7E+01	4.05E-04	--	2.9E+00	2.4E-01	1.42E+00	9.5E-03	1.42E+00	4.7E-04
156-59-2	cis-1,2-DCE	4.30E-02	3.6E+01	4.05E-04	--	1.7E-01	2.4E-01	1.42E+00	2.0E-01	1.42E+00	1.0E-02
127-18-4	PCE	2.02E-01	2.7E+02	4.05E-04	--	7.5E-01	2.4E-01	1.42E+00	5.0E-01	1.42E+00	2.5E-02
71-55-6	1,1,1-TCA	1.50E-02	1.4E+02	4.05E-04	--	7.1E-01	2.4E-01	1.42E+00	4.4E-02	1.42E+00	2.2E-03
79-00-5	1,1,2-TCA	1.80E-02	7.5E+01	4.05E-04	--	3.7E-02	2.4E-01	1.42E+00	8.7E-02	1.42E+00	4.3E-03
79-01-6	TCE	3.30E-01	9.4E+01	4.05E-04	--	4.2E-01	2.4E-01	1.42E+00	1.2E+00	1.42E+00	6.0E-02

$K_{oc}$  = soil organic carbon-water partition coefficient (L/kg)

$f_{oc}$  = organic carbon content of soil (kg/kg)

$K_d$  = soil-water partition coefficient (L/kg),  $K_{oc} \times f_{oc}$

$H'$  = dimensionless Henry's law constant

$O_w$  = site-specific average water-filled porosity (by volume)

$O_a$  = site-specific average air-filled porosity (by volume)

$P_b$  = dry soil bulk density (kg/L)

<sup>(1)</sup> Obtained from EPA Region 9 preliminary remediation goal (PRG) physical-chemical data for volatile organic compounds, November 2000

<sup>(2)</sup> Site-specific average values

<sup>(3)</sup> Obtained from EPA Soil Screening Guidance: Technical Background Document (TBD), EPA/540/R-95/128, dated July 1996, <http://www.epa.gov/oerrpage/superfund/resources/soil/tac.htm>

**Table B-11**  
**Summary of Risk Associated with VOC Vapor Migration from Groundwater as a Result of**  
**Leachate Migrating into Groundwater**

Chemical	Estimated Groundwater Concentration (mg/L)	Excess Cancer Risk	Estimated Hazard Index
1,1-DCA	0.013	$1.1 \times 10^{-10}$	0.00000023
1,2-DCA	0.0023	$5.4 \times 10^{-11}$	0.000000019
1,1-DCE	0.120	$1.7 \times 10^{-7}$	0.00014
cis-1,2-DCE	0.010	No Slope Factor	0.0000030
PCE	0.025	$2.4 \times 10^{-9}$	0.000032
1,1,1-TCA	0.0022	No Slope Factor	0.00000010
1,1,2-TCA	0.0043	$5.9 \times 10^{-11}$	0.00000073
TCE	0.060	$1.7 \times 10^{-9}$	0.0000027
Total		$1.8 \times 10^{-7}$	0.00018

**Table B-12. Summary of Cumulative Risks**

	Onsite Construction Worker (Highest of AOPC 1 and AOPC 2)	Onsite Commercial/Industrial Worker (Highest of AOPC 1 and AOPC 2)	Onsite Commercial/Industrial Worker (Highest of AOPC 1 and AOPC 2)	Onsite DTSC Commercial/Industrial Worker (Highest of AOPC 1 and AOPC 2)
<b>Hazard Index</b>				
Previously Estimated	0.051 NA	0.000064 0.0024		0.005 0.0024
Vapor Migration from Groundwater				
Vapor Migration from Deep Soil				
Leachate and Subsequent Volatilization from Groundwater	NA	0.00018	0.00018	0.00018
<b>Total</b>	0.051	0.0026	0.0026	0.0072
<b>Excess Cancer Risk</b>				
Previously Estimated	1.4E-06 NA	1.7E-10 2.9E-06	1.7E-10 2.9E-06	4.4E-06 2.9E-06
Vapor Migration from Groundwater				
Vapor Migration from Deep Soil				
Leachate and Subsequent Volatilization from Groundwater	NA	1.8E-07	1.8E-07	1.8E-07
<b>Total</b>	1.4E-06	3.1E-06	3.1E-06	7.5E-06

NA = Not applicable

AOPC = Area of Potential Concern (Two areas of potential concern were identified for Parcel A in the post-demolition risk assessment.)

**Table B-1. Site-specific Geotechnical Parameters at the BRC Former C-6 Facility**

Sample ID	Date Sampled	Depth (feet bgs)	Sieve Analysis (Soil Type)	Dry Bulk Density (kg/L)	Moisture Content (percent by weight)	Total Porosity (fraction by volume)	Air-filled Porosity (fraction by volume)	Water-filled Porosity (fraction by volume)	TOC* (mg/kg)	f <sub>oc</sub> (fraction by weight)
EIA290176-004 (I-34-20)	1/29/2001	20	Silt	1.54	17.5	0.42	0.15	0.27	330	0.0003
EIA290176-012 (D-29-20)	1/29/2001	20	Silt	1.55	17.0	0.41	0.15	0.26	430	0.0004
EIA29176-021 (I-25-20)	1/29/2001	20	Silt	1.37	20.2	0.48	0.20	0.28	410	0.0004
EIA290176-007 (I-34-50)	1/29/2001	50	Fine sand	1.35	4.4	0.51	0.45	0.06	230	0.0002
EIA29176-015 (D-29-50)	1/29/2001	50	Fine sand	1.36	19.5	0.49	0.22	0.26	560	0.0006
EIA29176-024 (I-25-50)	1/29/2001	50	Silt	1.34	24.3	0.51	0.18	0.32	470	0.0005

Average (25 feet bgs to groundwater table)

1.42

Average (50 feet bgs to groundwater table)

1.35

Notes:

The air-filled porosity values were calculated from gravimetric data, not volumetric data.

\* f<sub>oc</sub> = the weight fraction of organic carbon in soil = TOC/1,000,000

0.0004	0.47	0.23	0.24
0.0004	0.50	0.28	0.22